THE CHARACTER AND MAGNITUDE OF THE DENSE DUST-CLOUD WHICH PASSED OVER WASHINGTON, D.C., MAY 11, 1934

By IRVING F. HAND

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The dense dust-cloud which passed over Washington May 11, 1934, was noteworthy not only because observations showed a higher dust content of the atmosphere than ever has been measured by this Bureau before, but also because of its brief duration.

Unfortunately, on the morning of the 11th, when the cloud was first noticed, our Owens dust counter (**1**) was undergoing repairs in the machine shop and observations could not be taken until shortly after noon. Table 1 gives the results of these counts and also of similar measurements made on the two following days.

TABLE 1.—*Dust counts of May 11–13, inclusive, with auxiliary data*

Date and time	Location	Height, meters	Number of particles per cc	Average diameter of particles (reduced to cubes)	Visibility (miles)
1934					
May 11					
1:15 p.m.	American University	134	9,450	μ 1.0	¼
3:00 p.m.	Key Bridge, Georgetown	[1] 20	12,180	1.0+	⅛–¼
3:22 p.m.	American University	134	11,445	1.0+	¼
10:00 p.m.	do	134	3,150	1.0−	[2] 10
May 12					
5:00 a.m.	do	134	4,620	0.9	20
8:00 a.m.	do	134	903	.9	30
May 13					
5:00 a.m.	Harrisonburg, Va	[1] 370	1,155	.9	[1] 10
9:10 a.m.	Fisher's Gap, Va. (Blue Ridge)	[1] 1,000	693	.8	[1] 10
1:25 p.m.	No. 2 C.C.C. Camp, Va	[1] 1,100	609	.8	[1] 10
2:20 p.m.	Criglersville, Va	[1] 250	1,365	.9	[1] 10

[1] Estimated; in case of heights, topographic maps were consulted.
[2] Distance lights could be seen.

The largest number of atmospheric dust particles previously measured by this Bureau in Washington is 7,077 (**2**), so the value of 12,180 obtained at 3 p.m. on the 11th exceeds this previous maximum by 72 percent. After the passage of the main cloud, the dust drifted over the city in patches, as shown by the variation in counts made on the 12th. Measurements made in Virginia on the 13th show an unusually large number of particles on the Blue Ridge, but as no previous counts have been made in the Shenandoah Valley, we can only assume that the number there was larger than would be expected in free country air under ordinary circumstances. The size of the particles obtained on the Blue Ridge averaged considerably larger than previously had been measured there.

In order to simplify computation, the average volume of the particles has been estimated in cubical form. Dust particles generally have been assumed to be spherical in shape; examination, however, shows them to be in all manner of shapes with flat forms predominating. These forms have a tendency to deplete solar radiation receipt to a greater extent than would spherical particles of equal mass as flat forms tend to fall in a direction at normal incidence to the side with the greatest area.

From aerological and other sources, we have estimated the height of this cloud as 2 kilometers. Adopting the average vertical distribution of dust as determined from airplane observations (**3**), we find that the number of particles that actually were in a vertical column 2 kilometers high closely approximates the number that would be in a column 1 mile high having throughout the same dust density as that actually near the surface of the earth. Computations therefore have been made on this latter basis and in using either of the accompanying formulae, H_m should always be reduced to the height of even distribution.

Computing the weight of the dust, we have given 1.64×10^5 as the number of particles per cubic inch $6.1\times10^{-14}\text{in}^3$ as the average volume of the particles; 2.2; as the density and the height 1 mile. To determine the number of cubic inches in a mile, we have simply, $12^3\times 5{,}280^3=2.54\times10^{14}$. Then $(1.64\times10^5)\ (6.1\times10^{-14})=10^{-8}$, the number of cubic inches of dust in 1 cubic inch of air. Also $(2.54\times10^{14})\ (1.64\times10^5)$ gives 4.17×10^{19}, or the number of particles per cubic mile; or $(2.54\times10^{14})\ (10^{-8})=2.54\times10^6$, or the number of cubic inches of dust in one cubic mile.

Reducing to cubic feet in a cubic mile, $(2.54\times10^6)/(1.73\times10^3=1.47\times10^3$. Multiplying together the weight of a cubic foot of water, the density of this dust and the number of cubic feet of dust in a cubic mile and dividing by the weight of a short ton, we have

$$\frac{62.4\times2.2\times1.47\times10^3}{2\times10^3}=101$$

as the number of short tons over each square mile.

As would be expected, the diminution of solar radiation owing to absorption and scattering was enormous; amounting to about 75 percent. A value of 0.29 gram-calorie per minute per square centimeter of normal surface, received from the sun near noon with a comparatively water-free sky and through an air mass of 1.07, is exactly 25 percent of the normal for this air mass.

As Dr. William J. Humphreys has pointed out in his Physics of the Air, a continuation of a dust blanket of this magnitude would shortly result in ice-age conditions. Fortunately, while this cloud had considerable area, it was at a low level and most of it was carried to the surface with the first precipitation; much of it at sea, as rain did not fall in Washington until the 14th, and the cloud had a general easterly trend.

That this storm was of wide-spread area is evidenced by reports from other stations. Mr. Eric R. Miller, in charge of the Weather Bureau station at Madison, Wis., reports:

> At Madison only 0.82 inch of rain fell during the month, of which only 0.77 fell on the night of the 12th–13th. Much blowing dust from the Dakotas, Minnesota, and western Wisconsin. Worst dust storm on record on 10th, visibility less than 1 mile. Dust entered smallest crevices.

Unfortunately, cloudy skies prevented solar observations on the 10th, but observations taken early on the 11th gave values less than 50 percent of normal. Observations taken at Lincoln, Nebr., on the 10th show greatly depleted radiation receipt, but to a lesser degree than at either Washington or Madison which leads one to believe that the greater portion of the dust came from points north of Nebraska.

Quantitative and qualitative analyses by mere visual inspection showed that the particles averaged larger than usual and that the proportion of organic matter was considerably more than average. Minerals, loess, spores, plant-hairs, bits of decayed matter, glass, and transparent crystals were readily isolated and detected.

A flat beaker was placed on the roof of the solar radiation observatory at noon of the 11th, and taken down 24 hours later. Mr. M. E. Jefferson, of the Bureau of Chemistry and Soils, kindly consented to make a petrographic analysis of the contents of this beaker and his results are quoted herewith:

NOTE ON THE PETROLOGY OF THE DISTRICT OF COLUMBIA DUST STORM OF MAY 11, 1934

In connection with the observations on the dust storm discussed in the preceding paper, a sample of the dust was collected by Mr. I. F. Hand in an open beaker which was set out early on the 11th and taken in on the 12th at noon when the dust had practically disappeared from the air. The sample was examined under the petrographic microscope by immersion in the usual oils.

Quartz and gypsum were present in amounts great enough to be readily identified, while calcite was found in very small amounts in the form of small size particles. Orthoclase and microcline were identified and apparently showed no alterations. Quartz and feldspar were found to be clear and unstained. Mica was present but appeared altered at the edges to such an extent that identification was impracticable. It is apparently muscovite and biotite.

There was considerable isotropic material in the sample, none of which, however, could be definitely classified. Conchodial fragments had indices ranging from 1.45 to 1.60 and a few flat irregular fragments had less than 1.43, usually low.

The volcanic glass, hornblende, zircon, and tourmaline found by Alexander (4) in the Buffalo dustfall were not identified as such here.

Measurement of the particle size gave the range of diameter or length 0.001 mm to 0.13 mm with most of the mineral constituents in the range 0.005 to 0.04 mm. Winchell and Miller (5) found the range in the Madison dustfall to be 0.003 to 0.1 mm the quartz and feldspar in this case were stained with limonite and hematite. In the Buffalo storm Alexander reports lengths up to 0.05 mm. There is considerable opaque material of rather large particle size (0.01 to 0.1 mm) which we have made no attempt to identify.

The organic material present in this dust storm is much greater than that given by Alexander being at least 30 percent and consists of spores, stellate plant hairs, and vegetable fibers. No attempt was made to classify the spores and plant hair present. In several tests diatoms were recognized.

Dr. Charles F. Brooks, Director, Blue Hill Meteorological Observatory, Harvard University, Hyde Park, Mass., transmits the following note from C. A. Chapman:

DUST FROM CIRCULAR GLASS PLATE 25 CM IN DIAMETER AT MOUNT WASHINGTON, MAY 11 AFTER EXPOSURE ALL DAY

Amount of dust on the plate —— 0.011 —— grams.

The dust is very fine and varies from 5–30 microns in diameter. The average grain size is 10 microns.

For the most part the individual particles are decidedly angular and show no signs of frosting.

The dust consists principally of quartz and feldspar which exist as clear colorless grains.

Several species of diatoms are present but no attempt was made to identify any of them. They occur as small, porous, plant-like forms.

Other minerals identified as occurring in small amounts were sericite, green chlorite, iron oxides, and several aggregate masses of very fine-grained amorphous material.

LITERATURE CITED

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HOW A COMMERCIAL PILOT MAY CONTRIBUTE TO A PROGRAM OF AIR-MASS ANALYSIS BY OBSERVATIONS MADE DURING FLIGHT

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The need for analyzing weather as a three-dimensional system rather than merely as a two-dimensional one, such as is exemplified by the customary synoptic charts, has, among other things, brought about the regular daily use of airplane observations to heights of 17,000 feet or over as a permanent adjunct of the weather service. The planes now employed in this service are few in comparison with those in commercial use, hence there exists the possibility of securing a valuable addition to the scheduled soundings by enlisting the aid of commercial air pilots to record and make available meteorological observations made during their flights over the airways, just as many years ago the aid of mariners was enlisted for the collection of meteorological observations made on commercial vessels plying the trade routes of the Seven Seas.

In requesting the cooperation of pilots for the development of a program along this line, we should ask them to make their observations from the viewpoint which has contributed most to modern meterology, viz, physical weather analysis and air-mass analysis. However, before we may detail the character of the observations desired, we must first make clear just what we mean by these terms.

The fundamental concept of this method of analysis is based on the realization that our weather is caused, in general, by the expenditure and transformation of stored atmospheric energy (gravitational potential, and thermal) with the attendant interplay between air masses of markedly contrasting temperatures which have come into juxtaposition after having moved away from different respective regions over which they have recently been at rest, or wandering for a length of time sufficient to permit the environments to bring them to a state in regard to temperature, moisture content, and other features, more or less typical of these regions for the given time of year. The individual air masses do not freely mix with one another but tend to remain separate with more or less sharply defined boundary surfaces, or surfaces of discontinuity between them. Not infrequently, if not ordinarily, it is found that relatively thin transition zones serve instead of distinctly marked surfaces of discontinuity. Usually, rather marked changes in the characteristics of the respective air masses are observable as one crosses a surface of discontinuity, for the air masses on their travels tend to retain the characteristics of temperature, moisture content, and other properties which are normal for the regions from which they orig-